

## **Title: Modeling Drug Assimilation in the Human Body**

An exploration of the retention of various drugs in the human body using the absorption of green light, wavelength 565 nm, or red light, wavelength 635 nm, in solutions simulating drug behavior

### **Link to Outcomes:**

- **Communication** Students will work in cooperative groups investigating various drug assimilation rates; results will be merged among groups to complete laboratory investigations.
- **Problem Solving** Students will relate the rate of assimilation of several drugs within the body to mathematical models, extrapolating data to predict drug behavior and effects.
- **Reasoning** Students will gather absorption data, create scatter plots, and establish mathematical functions as models of drug behavior in the human body. Extrapolation of data will be used to make predictions of long-term use of harmful substances.
- **Connections** Students will observe connections between chemistry, biology, mathematics, and applications of derived functions across the curricula.
- **Measurement** Students will use the colorimeter probe of the Texas Instrument Calculator Based Laboratory (CBL) in conjunction with data analysis of the TI-82 graphics calculator (TI-82).
- **Algebra** Chemical and biological activity of drugs will be modeled with algebraic functions; exploration of data will lead to a predictive model of effects for long term substance abuse.
- **Technology** Students will use the CBL colorimeter probe to collect the percent transmittance of green light in various concentration values. The TI-82 will then be used to convert data to absorbance values and to perform statistical analysis on the results.
- **Cooperation** Students will gather data in cooperative group organization; resulting data will be discussed within the group and predictions made.

**Brief Overview:**

The color of an object is the result of reflected waves of light; complementary wavelengths are absorbed. The concentration of colored solutions, therefore, can be determined by measuring the absorption of a specific wavelength of light. This concept is utilized to collect data on the rate of assimilation of drugs in the human body. Solutions are prepared to represent concentration of drugs in the body at specific time intervals. Students will then use these samples to obtain absorption values of green light using the colorimeter probe of the CBL system. The COLORI and COLOR2 programs of the TI-82 are then used to convert absorbance into concentration, relating residual concentration to time. The resulting data will be analyzed for a best fit regression equation. From the graph of the equation, predictions will be made about the retention of various drugs over time and the effect of multiple doses of the drug. Biological, social, and medical consequences will be discussed.

**Grade/Level:**

Grades 10-12; Biology, Chemistry, Physics, Health, Algebra II/Trig, Pre-calculus, Calculus

**Duration/Length:**

This lesson will consist of 1 to 3 sessions, depending upon the additional activities and discussions pursued.

**Prerequisite Knowledge:**

Students should be familiar with the basic functions of the TI-82, as well as, its statistics mode. In Chemistry classes, a basic introduction to Beers Law should be presented; other classes can use the conversion of absorbance into concentration which is contained in the universal program. A knowledge of exponential functions, graphic interpretation, and algebraic manipulation is required.

**Objectives:**

Students will:

- use the TI-82 for basic functions.
- be able to perform regression analysis on the TI-82.
- be able to use the CBL for calorimetric analysis.
- be able to interpret graphic results.
- be able to contrast the assimilation of single dose drug ingestion verses multiple drug doses.
- be able to use the regression line to extrapolate data and make predictions.
- be able to apply predictions from the lab to biological, environmental, societal, and medical issues.

**Materials/Resources Printed Materials:**

- TI-82 Calculator with cable link
- TI CBL system
- Vernier calorimetric probe with DIN converter
- Instruction sheets for CBL
- TI-Graph Link
- Activity Sheets I-III
- CBL Instruction Sheet (Resource #1)
- TI-82 Functions Instruction Sheet (Resource #2)
- Prepared solutions reflective of concentration of drugs at various times (see Solution Preparation-Resource #3)
- COLOR1 (Resource #4) and COLOR2 (Resource #5) (TI 82/CBL programs written by Carolyn Doetsch)

**Development/Procedures:**

Arrange students in groups of 2 or 3 prior to the activity in order to utilize available technology. Distribute the materials and review procedures. Prepare solutions and make available. Activity One will model the retention of cough medication within the body over four-hour intervals, single dose. Activity Two models the effects of multiple doses of cough syrup over 36 hours and the subsequent assimilation by the body.

Each group is expected to submit a laboratory report, including purpose, data tables, graphs, conclusion questions, and concluding statement if the purpose was met and what was learned from the lab.

**Evaluation:**

Classroom observations and written assignments will be used for evaluation.

**Extension Activities:**

- Chemistry students could use colored water solutions of known concentrations to establish a graph of absorbance verses concentration. The slope of this line represents the  $k$  value used in converting absorbance to concentration values via Beer's Law,  $A = kC$ . The  $k$  value is currently determined within program COLOR1 for less advanced groups.
- Chemistry students could prepare standard solutions to be used in the first extension activity.
- A representative of the police department could be invited to discuss with classes the effects of drinking and driving.
- A representative of a drug rehabilitation program could be invited to discuss the physical, emotional, and societal impact of substance abuse.
- Interdiscipline unit could be developed with social studies as to the areas of the world in which illegal drugs have had a heavy impact, either in its abuse or as an income source.

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## **ACTIVITY I**

### **PRE-ACTIVITY QUESTIONS** **(Submit To Teacher Prior To Lab Activity)**

Introduction: In this exploratory lab, solutions have been prepared to model the assimilation of a single dose of cough syrup in the body. This initial dose is assigned a mass value of 16.0 grams. In this activity, you will investigate the rate at which a drug is removed from the body in data collected in four-hour intervals.

1. How much time do you think is required to reduce the concentration of an ingested drug to one-half of its original amount?
2. How much time do you think it will take for the drug to be completely removed from the body?

Name: \_\_\_\_\_

## ACTIVITY ONE: SINGLE DOSE OF COUGH SYRUP

### Purpose:

- To determine the rate by which a single dose of medication (cough syrup) is absorbed by the body
- To apply Beer's Law to determine the unknown concentrations of solution

### Materials:

- TI-82 Calculator with cable link
- CBL system
- Vernier calorimetric probe with DIN converter
- Instruction sheets for CBL - Resource #1
- TI- 82 Functions Instruction Sheet - Resource #2
- Prepared solutions reflective of concentration of drugs at various times (see Solution Preparation) - Resource #3
- COLORI (TI-82/CBL program written by Carolyn Doetsch) - Resource #4

### Procedure:

1. Obtain 10 cuvettes and label 1-10. Fill with corresponding solutions and cap. Dispose of any excess solution in the sink.
2. Obtain CBL, colorimeter and DIN converter, and graphing calculator.
3. Obtain instruction sheets for CBL and TI-82.
4. Connect CBL, TI-82, and colorimeter probe per CBL INSTRUCTION SHEET. Take readings from the colorimeter for each of the solutions; complete data table.
5. With data in place, analyze in order to establish the best fit regression line. Graph the time of the drug sample,  $L_1$  on the x-axis versus concentration of the drug sample in  $L_4$ . Refer to instruction sheet for TI-82 FUNCTIONS INSTRUCTION SHEET.
6. Using the TI-Graph Link, produce a copy of the following and attach to this report:
  - a. Regression values, including regression coefficient
  - b. Regression equation (out of  $Y=$ )
  - c. Regression graph
7. Complete conclusion questions.

$k =$  \_\_\_\_\_ (copy from end of program)

**DATA TABLE**

Time (hours) $L_1$	Transmittance % $(L_2)$	Absorbance $(L_3)$	Concentration (g) $(L_4)$

Conclusion:

1. State your regression equation which best models the data collected in this activity. (Answer to three significant figures, please.)
  - a. What regression analysis led to this equation (STAT CALC menu used)?
  - b. What name is given to the curve described by your analysis?
2. Using the graph of the regression equation, determine the following:
  - a. At time zero, how many grams of the drug are in the body? \_\_\_\_\_

- b. What is the concentration after four hours in the body? \_\_\_\_\_
  - c. What is the concentration after eight hours in the body? \_\_\_\_\_
  - d. What is the concentration after twelve hours in the body? \_\_\_\_\_
  - e. Is the concentration increasing or decreasing? \_\_\_\_\_
3. When will the concentration of the drug be reduced to half of its initial quantity? Describe how this value is determined from the graph.
4. When will the concentration of the drug equal to zero?
5. Relate answer Number 4 to the type of graph of your regression equation.
6. What implication does your answer to Number 4 have to the effects of long-term drug use?
7. What restrictions in the real world are the result of observations made in this activity?
8. What have you learned from this activity? Contrast your answers to the pre-activity questions with your current understanding of drug retention.



Name: \_\_\_\_\_

## **ACTIVITY II**

### **PRE-ACTIVITY QUESTIONS**

(Submit To Teacher Prior To Activity)

Introduction: In this activity, the assimilation of multiple doses of cough syrup in the body is modeled. As in a real-life situation, additional doses of medication are taken at four-hour intervals. Four additional doses are introduced and their assimilations are modeled by colored water solutions.

1. What happens to the amount of a drug absorbed by the body when successive doses are ingested?
2. How long will it take for the body to reduce the quantity of cough syrup to 8 grams after four doses are ingested over four-hour intervals?
3. When will all of the drug be removed from the body?

Name: \_\_\_\_\_

## ACTIVITY II MULTIPLE DOSES OF COUGH SYRUP

### Purpose:

- To determine the rate by which multiple doses of medication (cough syrup) are absorbed by the body
- To apply Beer's Law to determine the unknown concentrations of solution

### Materials:

- TI-82 Calculator with link cable
- CBL
- Vernier calorimetric probe with DIN converter
- Instruction sheets for CBL - Resource #1
- TI-82 Functions Instruction Sheet - Resource #2
- Prepared solutions reflective of concentration of drugs at various times (see Solution Preparation) - Resource #3
- COLORI (TI 82/CBL program written by Carolyn Doetsch) - Resource #4

### Procedure:

1. Obtain 5 cuvettes and label 1-5. Fill cuvettes with corresponding solutions and cap.
2. Obtain CBL, colorimeter and DIN converter, and graphing calculator.
3. Obtain instruction sheets for the CBL and TI-82.
4. Connect CBL, TI-82, and colorimeter probe per instruction sheet. Take readings from the colorimeter for each of the solutions; complete data table.
5. With data in place, analyze in order to establish the best fit regression line. Graph the time of the drug sample  $L_1$ , on the  $x$ -axis versus concentration of the drug sample in  $L_4$ . Refer to instruction sheet for TI-82 regression procedure.
6. Using the TI-Graph Link, produce a copy of the following and attach to this report:
  - a. Regression values, including regression coefficient
  - b. Regression equation (out of  $Y=$ )
  - c. Regression graph
7. Complete conclusion questions.

$k =$  \_\_\_\_\_ (from Activity I)

Number of samples = 5

**DATA TABLE**

Time (hours) $L_1$	Transmittance % $(L_2)$	Absorbance $(L_3)$	Concentration (g) $(L_4)$

Conclusion:

1. State regression equation which best models the data collected in this activity. (Answer to three significant figures, please.)
  - a. What regression analysis led to this equation (STAT CALC menu used)?
  - b. What name is given to the curve described by your analysis?
  - c. What source of error is observed in this regression that was absent in activity one?
2. Using the graph of the regression equation, determine the following:
  - a. At time zero, how many grams of the drug are in the body? \_\_\_\_\_
  - b. What is the concentration after four hours in the body? \_\_\_\_\_
  - c. What is the concentration after eight hours in the body? \_\_\_\_\_
  - d. What is the concentration after twelve hours in the body? \_\_\_\_\_

e. Is the concentration increasing or decreasing? \_\_\_\_\_

3. From your graph, determine the amount of the drug absorbed by the body after 24 hours of drug doses, four hours apart.
4. What implication does your answer to question Number 3 have to the effects of long-term drug use?
5. What restrictions in the real world are the result of observations made in this activity?
6. What have you learned from this activity? Contrast your answers to the pre-activity questions with your current understanding of drug retention.

Name: \_\_\_\_\_

**ACTIVITY III**  
**PRE-ACTIVITY QUESTIONS**  
(Submit To Teacher Prior To The Lab)

Introduction: Activity III is a follow up to the five doses of cough syrup modeled in Activity II. The assimilation of the drug is again represented by colored water solutions during a 36-hour time period. Samples are taken at four-hour intervals with no additional doses of drugs.

1. From Activities I and II, predict the time required to reduce the amount of drugs in the body after five doses of cough syrup to one-half of its final concentration, dose five.
  
  
  
  
  
  
  
  
  
  
2. Will the time predicted in question 1 be greater than, less than, or equal to the time required in Activity I? Justify your response.
  
  
  
  
  
  
  
  
  
  
3. From the mathematical model established in Activities I and II, do you predict that the drug will ever be totally removed from the body?

Name: \_\_\_\_\_

### ACTIVITY III

### STUDY OF DRUG RETENTION AFTER MULTIPLE DOSES

**Purpose:**

- To determine the rate of which multiple doses of medication (cough syrup) is retained by the body
- To apply Beer's Law to determine the unknown concentrations of solution

**Materials:**

- TI-82 Calculator with link cable
- TI CBL system
- Vernier calorimetric probe with DIN converter
- CBL INSTRUCTION SHEET - Resource #1
- TI-82 FUNCTIONS INSTRUCTION SHEET - Resource #2
- Prepared solutions reflective of concentration of drugs at various times (see Solution Preparation) - Resource #3
- COLOR2 (TI-82/CBL program written by Carolyn Doetsch) - Resource #5

**Procedure:**

1. Pick up 10 curvettes and label 1-10. Fill with corresponding solutions and cap.
2. Pick up CBL, colorimeter and DIN converter, and graphing calculator.
3. Pick up instruction sheets, CBL, and TI-82.
4. Connect CBL, TI-82, and colorimeter probe per instruction sheet. Take readings from the colorimeter for each of the solutions; complete data table.
5. With data in place, analyze data in order to establish the best fit regression line. Graph the time of the drug sample,  $L_1$ , on the  $x$ -axis versus concentration of the drug sample,  $L_4$ . Refer to instruction sheet for TI-82 regression procedure.
6. Using the TI Graph Link, produce a copy of the following and attach to this report:
  - a. Regression values, including regression coefficient
  - b. Regression equation (out of  $Y=$ )
  - c. Regression graph
7. Complete conclusion questions.

$k =$  \_\_\_\_\_ (from Activity I)

Number of samples = 10

**DATA TABLE**

Time (hours) $L_1$	Transmittance % $(L_2)$	Absorbance $(L_3)$	Concentration (g) $(L_4)$

Conclusion:

1. State your regression equation which best models the data collected in this activity (Answer to three significant figures, please).
  - a. What regression analysis led to this equation (STAT CALC menu used)?
  - b. What name is given to the curve described by your analysis?
2. Using the graph of the regression equation, determine the following:
  - a. At time zero, how many grams of the drug are in the body? \_\_\_\_\_
  - b. What is the concentration after four hours in the body? \_\_\_\_\_

- c. What is the concentration after eight hours in the body? \_\_\_\_\_
  - d. What is the concentration after twelve hours in the body? \_\_\_\_\_
  - e. Is the concentration increasing or decreasing? \_\_\_\_\_
3. Compare the concentrations of Question 2 in this activity to the concentrations of Activity I. What is the source of difference between the sets of data?
4. What are the implications of this activity to long-term drug use?
5. Relate the results of this activity to how you feel after being sick and taking cold medication for several days. Do you feel sluggish? Is this related to the results of this activity?
6. This exercise models a drug which does not have high solubility in fat cells; some drugs, such as PCP, on the other hand, are highly fat soluble and are stored in fat cells for much longer periods of time. How would that change your regression equation? The resulting graph?
7. What would be the effect on the concentration of PCP in the blood stream if a person (not currently using the drug) underwent strenuous exercise or a strict diet resulting in weight loss?
8. What have you learned from this activity? Contrast your answers to the pre-activity questions with your current understanding of drug retention.



**CBL INSTRUCTION SHEET****Use of the TI-82/CBL for sampling:**

1. Attach the colorimeter probe to the DIN connector; attach the DIN connector to Channel 1 port at the top of the CBL unit. Using the TI-82 link cable, link calculator from the I/O port at the bottom of the calculator to the I/O port at the bottom of the CBL. **BE SURE TO PUSH IN FIRMLY!**
2. Turn on calculator; press {prog} (program) key; leave **EXEC** highlighted; toggle to **COLORI** program; press {eNter}, {eNter}.
3. Turn on CBL unit.
4. Select **(1) CALIBRATE** on the calculator screen; press {eNter}.
  - a. Close the lid of the colorimeter (no cell).
  - b. Set the knob on the colorimeter to 0%T.
  - c. Allow the reading on the CBL to come to a constant reading.
  - d. Press the [Trigger] button on the CBL.
  - e. Enter 0 when asked to "ENTER REFERENCE."
  - f. Set the knob on the colorimeter to the green wavelength.  
NOTE: If using red dye, set knob to green;  
if using green dye, set to red.
  - g. Insert a BLANK curvette filled with water into the colorimeter, **PUSHING DOWN FIRMLY** (you should hear it snap in).  
**(MAKE SURE THAT the RIBBED edges of the curvette are facing the front of the colorimeter and not blocking the light beam.)**
  - h. Allow the reading on the CBL to come to a constant reading.
  - i. Press the [Trigger] button on the CBL.
  - j. Enter 100 at the "ENTER REFERENCE."
5. Select **(3) COLLECT DATA ON** the calculator screen; press {eNter}.
  - a. Replace water curvette with solution I curvette.
  - b. Close top of colorimeter.
  - c. Press trigger button on CBL.
  - d. When new reading appears on calculator screen, remove solution curvette.
  - e. Repeat Number 5 a-d with remaining curvettes.
4. When all data has been collected, select **(4) QUIT** on the calculator screen.
5. Perform statistical operations with data, using TI-82 Functions Instruction Sheet.

NOTE: If the CBL unit is turned off, you **MUST** calibrate the instrument **AGAIN** before taking another sample.

## TI-82 FUNCTIONS INSTRUCTION SHEET

1. {stat} {4} {2nd} {l 1} {,} {2nd} {l 2} etc. {eNter} to clear out all lists.
2. {stat} {1} to enter **STAT EDIT** menu.
3. Enter data using the CBL.
4. To display the lists - {stat} {1}.
5. After entering and sorting data, set up the statistical calculations, then perform the calculations, storing the equations in **Y=** list.
6. Press {stat} {H} to display **STAT CALC** menu.
  - a. Press {3} to select **SetUp...** Xlist for 2-VAR should be  $L_1$  (absorbance)  
Ylist for 2-VAR should be  $L_3$  or  $L_4$  (concentration)  
Freq should be 1
  - b. {stat} {H} {5} to select regression formula. Press {eNter} to calculate.  
Observe the value of  $r$  (correlation coefficient). The closer  $r$  is to -1 (or 1) the better the “fit” of the curve. Keep repeating different regression equations until you determine the best fit.
  - c. Press **Y=** and move to variable you want to assign.
  - d. Press {vars} {5} (to select **Statistics...**) {H} {H} (to display the **VARs EQ** menu) {7} (to select **RegEQ**).
7. To plot statistical data, you must enter the data in lists and then define the plot.
  - a. Press {2nd} {y=} [STAT PLOT] to display the **STAT PLOTS** screen.
  - b. Press {1} (to display the Plot1 screen). Press {eNter} to turn Plot1 **ON**. Leave Type as a scatter plot, Xlist as  $L_1$ , Ylist as  $L_3$  or  $L_4$ , and Mark as a  $\square$ .
  - c. Press {zoom} {9} (to select **ZoomStat**).
  - d. Press {trace}. Press {H} to trace points in Plot1 as indicated by P1 in the upper right hand corner of the display. Press {G} to move to  $Y_1$ . Press {G} again to move to  $Y_2$ .

**SOLUTION PREPARATION**

**Solution I:** Take  $\frac{1}{2}$  cup of water and put in 6 drops of food coloring (red or green). This concentration will represent a concentration of 16 grams of cough syrup. Since the rate of retention of the cough syrup in the body is 75% every four hours, the following dilutions will reflect the concentration changes in the blood:

Soln 1	Time 0 hr:	$\frac{1}{2}$ cup water, 6 drops of food coloring	16 g
Soln 2	Time 4 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	12 g
Soln 3	Time 8 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	9 g
Soln 4	Time 12 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	6.75 g
Soln 5	Time 16 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	5.06 g
Soln 6	Time 20 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	3.80 g
Soln 7	Time 24 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	2.85 g
Soln 8	Time 28 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	2.14 g
Soln 9	Time 32 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	1.60 g
Soln 10	Time 36 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water	1.20 g

**Solution II:** Take  $\frac{1}{2}$  cup of water and put in 6 drops of food coloring (red or green). This concentration will represent a concentration of 16 grams of cough syrup. In this activity, additional doses of cough syrup will be taken at four hour intervals; the level of the retained cough syrup will increase, as noted in the grams retained, column 4.

Soln 1	Time 0 hr:	$\frac{1}{2}$ cup water, 6 drops of food coloring	16 g
Soln 2	Time 4 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water add 6 drops additional food coloring	28 g
Soln 3	Time 8 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water add 6 drops additional food coloring	37 g
Soln 4	Time 12 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water add 6 drops additional food coloring	43.75g
Soln 5	Time 16 hr:	remove $\frac{1}{8}$ cup solution, replace with $\frac{1}{8}$ cup water add 6 drops additional food coloring	48.8g

**Solution III:** Take the solution resulting in the Soln 5 and allow the “cough syrup” to be assimilated by the body as reflected in SOLUTION I.

Soln 1	Time 0 hr:	Solution 5 from above	
Soln 2	Time 4 hr:	remove 1/8 cup solution, replace with 1/8 cup water	36.6g
Soln 3	Time 8 hr:	remove 1/8 cup solution, replace with 1/8 cup water	27.5g
Soln 4	Time 12 hr:	remove 1/8 cup solution, replace with 1/8 cup water	20.6g
Soln 5	Time 16 hr:	remove 1/8 cup solution, replace with 1/8 cup water	15.4g
Soln 6	Time 20 hr:	remove 1/8 cup solution, replace with 1/8 cup water	11.6g
Soln 7	Time 24 hr:	remove 1/8 cup solution, replace with 1/8 cup water	8.70g
Soln 8	Time 28 hr:	remove 1/8 cup solution, replace with 1/8 cup water	6.53g
Soln 9	Time 32 hr:	remove 1/8 cup solution, replace with 1/8 cup water	4.89g
Soln 10	Time 36 hr:	remove 1/8 cup solution, replace with 1/8 cup water	3.67g

## COLORI

File Name: COLORI.82P Type: Program Protected: No  
 Comment: Program file dated 11/14/95 19:15

```
:Disp "BY CAROLYN DOETSCH"
:Disp "VA BEACH CITY SCHOOLS"
:ClrHome
:ClrDraw
:ClrList L1,L2,L3,L4,L5,L6
:FnOn
:
:10→N
:
:16→O
:{1,0}→L1
:Send(L1)
:{1,1,1}→L6
:Send(L6)
:Lbl 1
:{3,..25,1,1}→L6
:Send(L6)
:Menu("COLORIMETER", "CALIBRATE", 2, "COLLECT DATA", 3, "QUIT", 4)
:Lbl 2
:2→dim L1
:2→dim L2
:For(I,1,2,1)
:{3,..25,1,1}→L6
:Send(L6)
:ClrHome
:Disp I
:Disp "MONITER CBL."
:Disp "WHEN VOLTAGE"
:Disp "IS STABLE, PRESS"
:Disp "CBL [TRIGGER]"
:Get(L1(I))
:Input "ENTER REFERENCE: ", R
:R→L2(I)
:End
:LinReg(ax+b) L1, L2
:{4,1,1,1,b,a}→L6
:Send(L6)
:{1,1,1,0,0,1}→L6
:Send(L6)
:{3,..25,1,1}→L6
:Send(L6)
```

```

:Goto 1
:Lbl 3
:ClrHome
:0→C
:N→dim L1
:N→dim L2
:N→dim L3
:N→dim L4
:N→dim L5
:
:Disp "READY EXPERIMENT"
:Disp "PRESS [ENTER]"
:Disp "TO START"
:Pause
:Lbl A
:Disp "HIT CBL [TRIGGER]"
:{3,30,1,1}→L6
:Send(L6)
:
:C+1→C
:Get(L2(C))
:If L2(C)≤0.1:0.1→L2(C)
:log (100/L2(C))→L3(C)
:30*C→L4(C)
:Disp L2(C)
:If C<N
:Goto A
:
:0→K
:For(I,1,3,1)
:K+L3(I)/( .75^(I-1))*O→K
:End
:K/3→K
:
:
:For(I,1,N,1)
:L3(I)/K→L4(I)
:4*(I-1)→L4(I)
:End
:Goto 1
:Lbl 4
:Disp "K=", K
:Stop

```

## NOTES REGARDING THE PROGRAM

$N$  = number of samples which will be taken

$O$  = volume of water to start

$L_1$  = Number of hours (currently in 4 hour increments)

$L_2$  = Transmittance data (% Transmittance)

$L_3$  = Absorbance data

$L_4$  = Quantity of drug remaining  $L_3/k$  (grams in the body)

$k$  = constant derived from the first 3 transmissions

## COLOR2

File Name: COLOR2.82P    Type: Program    Protected: No  
 Comment: Program file dated 11/14/95, 19:15

```
:Disp "BY CAROLYN DOETSCH"
:Disp "VA BEACH CITY SCHOOLS"
:ClrHome
:ClrDraw
:ClrList L1, L2, L3, L4, L5, L6
:FnOn
:Input "NUMBER OF SAMPLES", N
:
:Prompt K
:16→0
:{1,0}→L1
:Send(L1)
:{1,1,1}→L6
:Send(L6)
:Lbl 1
:{3,..25,1,1}→L6
:Send(L6)
:Menu("COLORIMETER", "CALIBRATE", 2, "COLLECT DATA", 3, "QUIT", 4)
:Lbl 2
:2→dim L1
:2→dim L2
:For(I,1,2,1)
:{3,..25,1,1}→L6
:Send(L6)
:ClrHome
:Disp I
:Disp "MONITER CBL."
:Disp "WHEN VOLTAGE"
:Disp "IS STABLE, PRESS"
:Disp "CBL [TRIGGER]"
:Get(L1(I))
:Input "ENTER REFERENCE:", R
:R→L2(I)
:End
:LinReg(ax+b) L1, L2
:{4,1,1,1,b,a}→L6
:Send(L6)
:{1,1,1,0,0,1}→L6
:Send(L6)
:{3,..25,1,1}→L6
:Send(L6)
```



```

:Goto 1
:Lbl 3
:ClrHome
:0→C
:N→dim L1
:N→dim L2
:N→dim L3
:N→dim L4
:N→dim L5
:
:Disp "READY EXPERIMENT"
:Disp "PRESS [ENTER]"
:Disp "TO START"
:Pause
:Lbl A
:Disp "HIT CBL [TRIGGER]"
:{3,30,1,1}→L6
:Send(L6)
:
:C+1→C
:Get(L2(C))
:If L2(C)≤0.1:0.1→L2(C)
:log (100/L2(C))→L3(C)
:30*C→L1(C)
:Disp L2(C)
:If C<N
:Goto A
:
:
:
:For(I,1,N,1)
:L3(I)/K→L4(I)
:4*(I-1)→L1(I)
:End
:Goto 1
:Lbl 4
:Stop

```

## NOTES REGARDING THE PROGRAM

$N$  = number of samples which will be taken

$O$  = volume of water to start

$L_1$  = Number of hours (currently in 4 hour increments)

$L_2$  = Transmittance data (% Transmittance)

$L_3$  = Absorbance data

$L_4$  = Quantity of drug remaining  $L_3/k$  (grams in the body)

$k$  = constant derived from the first 3 transmissions